REMARKS

On March 18, 2009 applicants' attorney responded to a restriction requirement by electing the invention of Group 1, claims 1-10, without traverse. This election is affirmed. Claims 11-20 have been amended to depend from Claim 1, thereby bringing them into the Group 1 invention. The restriction requirement does not affect the inventorship in this application.

Claims 1-7 and 9 were rejected under 35 U.S.C. §102(b) as being anticipated by US patent publication US2003/0204142 (Brock-Fisher et al.) which is assigned to the same assignee as the present invention. Claim 1 describes a method of ultrasonically imaging blood perfusion and blood flow in a region of interest of a body comprising acquiring a sequence of ultrasonic echo signals from a body which has been infused with an ultrasonic contrast agent; processing the echo signals to detect the tissue structure in the absence of microbubbles; processing a plurality of the echo signals in a first way to detect echo signals returned from tissue microvasculature perfused with the contrast agent; processing a plurality of the echo signals in a second way to detect echoes returned from blood flow containing the contrast agent in larger vessels; utilizing the echo signals processed the first way to form a portion of an image depicting perfusion; utilizing the echo signals processed the second way to form a portion of an image depicting blood flow in larger vessels; and displaying an ultrasound image depicting both contrast-enhanced perfusion and contrast-enhanced blood flow. When a clinician is imaging with contrast agents, he is generally trying to use the contrast agent to image blood flow in large blood vessels, or to assess the perfusion of the microvasculature in tissue. However since blood vessels and tissue are intermingled in the body and thus usually intermingled in the ultrasound image, it is often difficult to discern whether contrast agent is in one or the other. The present invention enables the flow in blood vessels and tissue microvasculature to be distinguished or segmented by processing echo signals from contrast in two different ways, one which preferentially detects echo signals from the contrast agent in tissue

microvasculature and another which preferentially detects echo signals from blood flow in larger vessels. The two types of blood flow can then be distinguished in their respective locations in the image as by highlighting or shading or coloring them differently so that the clinician encounters no ambiguity which trying to diagnose either tissue perfusion characteristics or vessel blood flow characteristics. In a preferred embodiment as shown in FIGURES 4A and 4B, the two types of blood flow are classified and segmented using two parameters, velocity variance and echo signal power. Signals exhibiting lower mean velocities and higher power are classified as coming from tissue perfusion, and signals exhibiting higher mean velocities and relatively lower power are classified as flow in larger blood vessels. An embodiment of the present invention thus enables the clinician to discern contrast perfused tissue microvasculature from contrast flowing in larger blood vessels.

Brock-Fisher et al. are not concerned with and do not suggest how to distinguish tissue perfusion from larger vessel blood flow. They are concerned with reducing echoes from tissue and stationary contrast agent so that the color flow image will only highlight flowing contrast agent. This is done with two clutter filters, one which removes tissue echo signals and a second which removes echo signals from stationary contrast agent microbubbles. The common characteristic of tissue and stationary microbubbles is that their velocity of movement measured by the Doppler shift is at or near zero: tissue generally moves much slower than blood flow, if at all, and stationary microbubbles likewise have a velocity at or near zero. The sequence of removing these signals is shown in Fig. 9 of Brock-Fisher et al. In step 910 the responses from tissue are suppressed from the echoes. As explained in paragraph [0083], the tissue response is removed by a clutter filter in a tissue-signal processor 810. The echo signals with the tissue response removed are then processed by a color flow algorithm in step 912. As stated in paragraph [0087], the color flow algorithm includes another clutter filter 500 which removes the effect of echoes from stationary microbubbles. What is left is echo signals from blood flow, which is imaged. As Brock-Fisher et al. state in paragraph [0077], "the

cumulative effect of the two filters and the power-modulation technique(s) is to reduce tissue generation signals and stationary contrast-bubble signals, while passing signals generated from moving contrast-agent bubbles." This is a very good way to image the blood flow in larger vessels where the contrast agent flows freely, as other motional effects have been eliminated.

Fig. 10 of Brock-Fisher et al. adds a further improvement, which is to correct blood flow velocity measurements for the motion of tissue in which the blood flow occurs. The ultrasound probe, being stationary on or in the body, will measure all velocities as relative to the speed of the probe, which is zero. But suppose a blood vessel had a blood flow velocity of 4 cm/sec and the vessel was in moving tissue such as a coronary artery on the myocardium of the heart. Since the myocardium is always moving as the heart beats, components of this tissue motion will add or subtract from that of the coronary blood flow. If the heart is moving in the same direction as the blood flow, the combination of the two will be seen by the probe; a 2 cm/sec component of motion in the same direction as the 4 cm/sec blood flow will appear to have a velocity of 6 cm/sec to the stationary probe. The embodiment of Brock-Fisher et al.'s Fig. 10 compensates for this. In parallel with the suppression of tissue response 1010 and the color flow algorithm 1012 with its clutter filter, the same steps as shown in Fig. 9, the tissue velocity is determined in step 1011. This tissue velocity measurement is then used to correct the contrast agent flow velocity in step 1020. In our example above, the blood flow will be corrected to its true 4 cm/sec rather than being measured as 6 cm/sec.

Both of these embodiments are seen to be unconcerned with perfusion, and in particular to segmenting tissue perfusion from larger vessel blood flow by different ways of processing. In fact, the word "perfusion" is only mentioned twice in the application, once in paragraph [0005] where it is stated that contrast agents are effective for detecting perfusion and again in paragraph [0027] where it is said that the Brock-Fisher et al. invention can be used for blood-perfusion imaging. But Brock-Fisher et al. are silent on any way to segment microvasculature perfusion from larger vessel blood

flow. Thus it is respectfully submitted that Brock-Fisher et al. cannot anticipate Claim 1 or its dependent Claims 2-20.

Claim 8 was rejected under 35 U.S.C. §103(a) as being unpatentable over Brock-Fisher et al. in view of US Pat. 6,095,980 (Burns et al.) Burns et al. was cited for its reference to the pulse inversion technique for nonlinear (harmonic) separation, although pulse inversion was also mentioned in Brock-Fisher et al. in paragraph [0065]. It is seen that Burns et al. are concerned with segmenting signals from tissue motion, harmonic contrast agents, and harmonic signals from tissue. Like Brock-Fisher et al., Burns et al. are unconcerned with segmenting microvasculature perfusion from larger vessel blood flow. The term perfusion is mentioned only once by Burns et al., to say that power Doppler is a good technique for imaging perfused tissue. Accordingly it is respectfully submitted that the combination of Brock-Fisher et al. and Burns et al. cannot render Claim 1 and its dependent claims including Claim 8 unpatentable.

Claim 10 was rejected under 35 U.S.C. §103(a) as being unpatentable over Brock-Fisher et al. in view of Burns et al. and further in view of US Pat. 6,620,103 (Bruce et al.) Bruce et al. are detecting slow-moving microbubbles by time-interleaving the pulse pairs that are transmitted along each line of the image field. Since the microbubbles are moving very slowly, they only have to be interrogated at widely spaced intervals to detect their motion. A moving target indicator can then be used to detect their low velocity or their progressive locations marked on the ultrasound image in what is known as "bubble-tracking." Like the other two citations, Bruce et al. are unconcerned with segmenting contrast perfusion of tissue microvasculature from flowing contrast in larger vessels. The word perfusion is mentioned only once by Bruce et al., in the second paragraph of the patent. Accordingly it is respectfully submitted that the combination of Brock-Fisher et al., Burns et al., and Bruce et al. cannot render Claim 1 and its dependent claims including Claim 10 unpatentable.

In view of the foregoing amendment and remarks it is respectfully submitted that Claims 1-20 are not anticipated by Brock-

Fisher et al., and that Claims 1-20 are patentable over Brock-Fisher et al., Burns et al., and Bruce et al. Accordingly it is respectfully requested that the rejection of Claims 1-7 and 9 under 35 U.S.C. §102(b) and of Claims 8 and 10 under 35 U.S.C. §103(a) be withdrawn and Claims 1-20 passed on to issuance.

In light of the foregoing amendment and remarks, it is respectfully submitted that this application is now in condition for allowance. Favorable reconsideration is respectfully requested.

Respectfully submitted,

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